Introduction

This training program is designed for students with basic ROS 2 knowledge. It focuses on navigation, localization, waypoint navigation, and mission control using state machines. The course uses TurtleBot simulation and RTAB-Map.

1 Module 1: Introduction & Setup

Objectives:

- Install ROS 2 and TurtleBot3 packages
- Setup workspace and simulation environment (Gazebo + RViz)
- Verify sensor topics (LiDAR, odometry, camera)

Exercises:

- Create ROS 2 workspace and build
- Run TurtleBot3 simulation world
- Check sensor topics with `ros2 topic list`

2 Module 2: Mapping with RTAB-Map

Objectives:

- Understand SLAM and RTAB-Map
- Run RTAB-Map in simulation
- Save and load maps

Exercises:

- Launch TurtleBot3 with RTAB-Map
- Explore environment to build map
- Save map using `ros2 run nav2_map_server map_saver_cli`

3 Module 3: Localization with RTAB-Map

Objectives:

- Use pre-built maps for localization
- Understand TF tree: map → odom → base_link

Exercises:

- Launch localization node with map.yaml
- Move robot and verify pose in RViz

4 Module 4: Navigation with Nav2

Objectives:

- Learn Navigation2 stack

- Configure global and local planners

- Tune costmap parameters

Exercises:

- Launch nav2_bringup with TurtleBot

- Send a navigation goal in RViz

- Observe path planning and execution

5 Module 5: Waypoint Navigation

Objectives:

- Define and manage multiple waypoints

- Create patrol behavior using waypoints

Exercises:

- Write Python node to send multiple goals

- Test waypoint navigation in simulation

6 Module 6: State Machines for Mission Control

Objectives:

- Understand state machines in robotics

- Implement mission logic with SMACH or FlexBE

Exercises:

- Create simple state machine with two states

- Expand mission with patrol → detect → return

7 Module 7: Advanced Topics & Real Robot Integration

Objectives:

- Handle kidnapped robot problem
- Fuse IMU + odometry + RTAB-Map
- Deploy to a real TurtleBot

Exercises:

- Test re-localization after manual robot displacement
- Run mapping on physical TurtleBot

Final Project

Students implement a complete mission-based program:

- Explore and build map with RTAB-Map
- Localize using saved map
- Patrol using waypoints
- Implement mission logic with state machine